Earth Science Enterprise Technology Program

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Strategy, Vision, and Implementation

Presentation to Technology Strategy Team
YF/Gran Paules
ESTO/George Komar
GSFC/Mike Ryschkewitsch
27 January 1999

Agenda

- Overview of ESE Technology Strategy and Implementation Program
  - **HQ/G. Paules**
  - **ESTO/G. Komar ~ 1 hour**
- Future Vision and Architecture for Earth Science--technology focus
  - **Grand Challenges will be referenced at appropriate points**
  - **GSFC/M. Ryschkewitsch- ~ 1 _ hour**
- Status of "Digital Earth" activities
  - **GSFC/H. Mitchell ~ _ hour**

Post-2002 Mission Scenario Planning

- **A Major Science/Applications Program Review**
  - June-August 1998
  - Ideas solicited through a RFI
- **Two-step process**
  - disciplined synthesis of concepts based on science and applications questions
    - » formulated a profile of nominal measurement scenarios with options
  - workshop review established consensus of results
    - » presented to an Interdisciplinary Panel of distinguished scholars
- **Mission Scenario 2002-2010 Profile released**
  - Measurement-driven rather than instrument-driven concepts

Key Findings from RFI Process

- Three specialized categories of **science-based mission concepts**
  - EOS follow-on program and transition to operational systems for **key systematic measurements**, as appropriate
  - Earth Probe program for ground-breaking, **one-of-a-kind exploratory science missions**
  - New Millennium program for **innovative technology demonstration**
- **Applications mission concepts** were introduced for further investigation

Science/Applications Measurement Sets

Atmospheric Chemistry
- Stratospheric Chemistry
- Tropospheric Chemistry

Atmospheric Physics
- Aerosol Properties
- Atmospheric Humidity
- Atmospheric Temperature
- Cloud Properties
- Radiative Energy Fluxes
- Total Solar Irradiance

Geodynamics, Geology & Applications
- #Earth Surface Deformation Mapping
- #Gravity Field Mapping
- #Magnetic Field Mapping
- Volcanic Ash Cloud Tracking

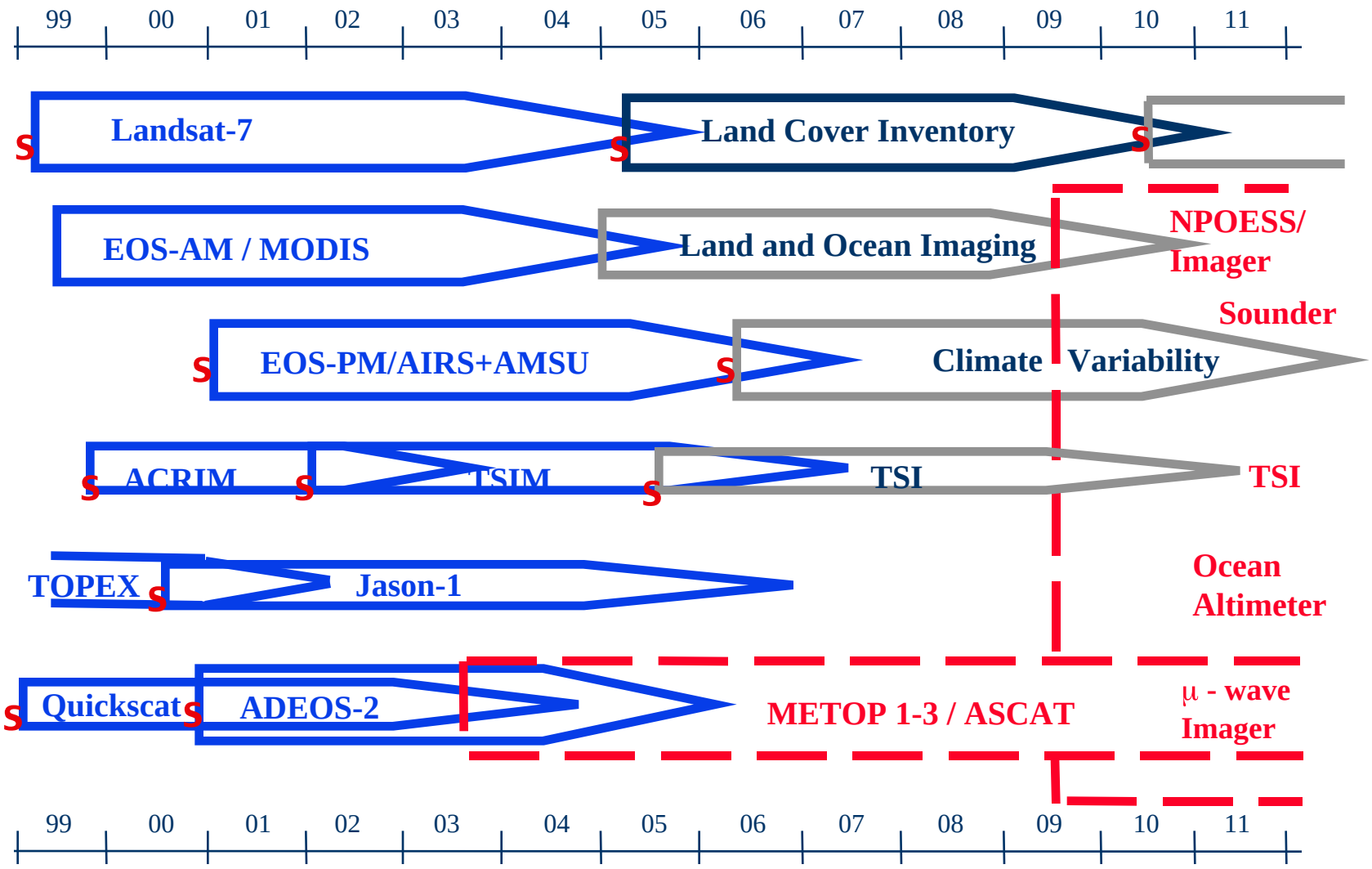
Global Water Cycle and Weather
- Cold Hydrologic Process
- Precipitation
- #Soil Moisture
- #Surface Flow
- #Tropospheric Wind

Land Cover and Terrestrial Ecosystems
- Land Cover & Land Use Change
- Vegetation Disturbance Recovery

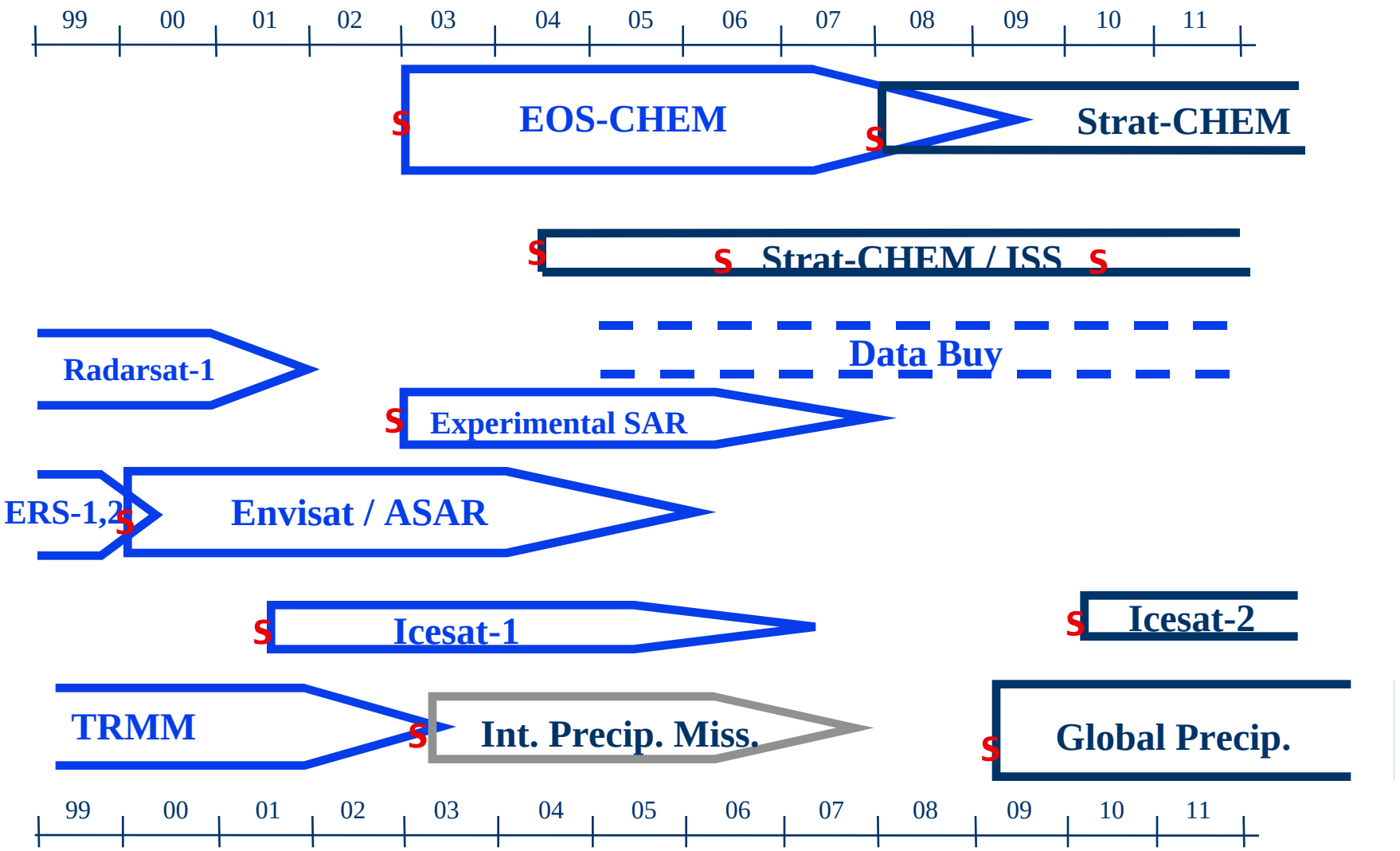
Natural Hazards
- Lightning/Volcanic Ash Cloud/Fire Occurrence

Ocean and Ice
- Ice Sheet Mass Balance
- Ocean Color Mapping
- Ocean Surface Topography
- Ocean Surface Wind
- #Sea Surface Salinity

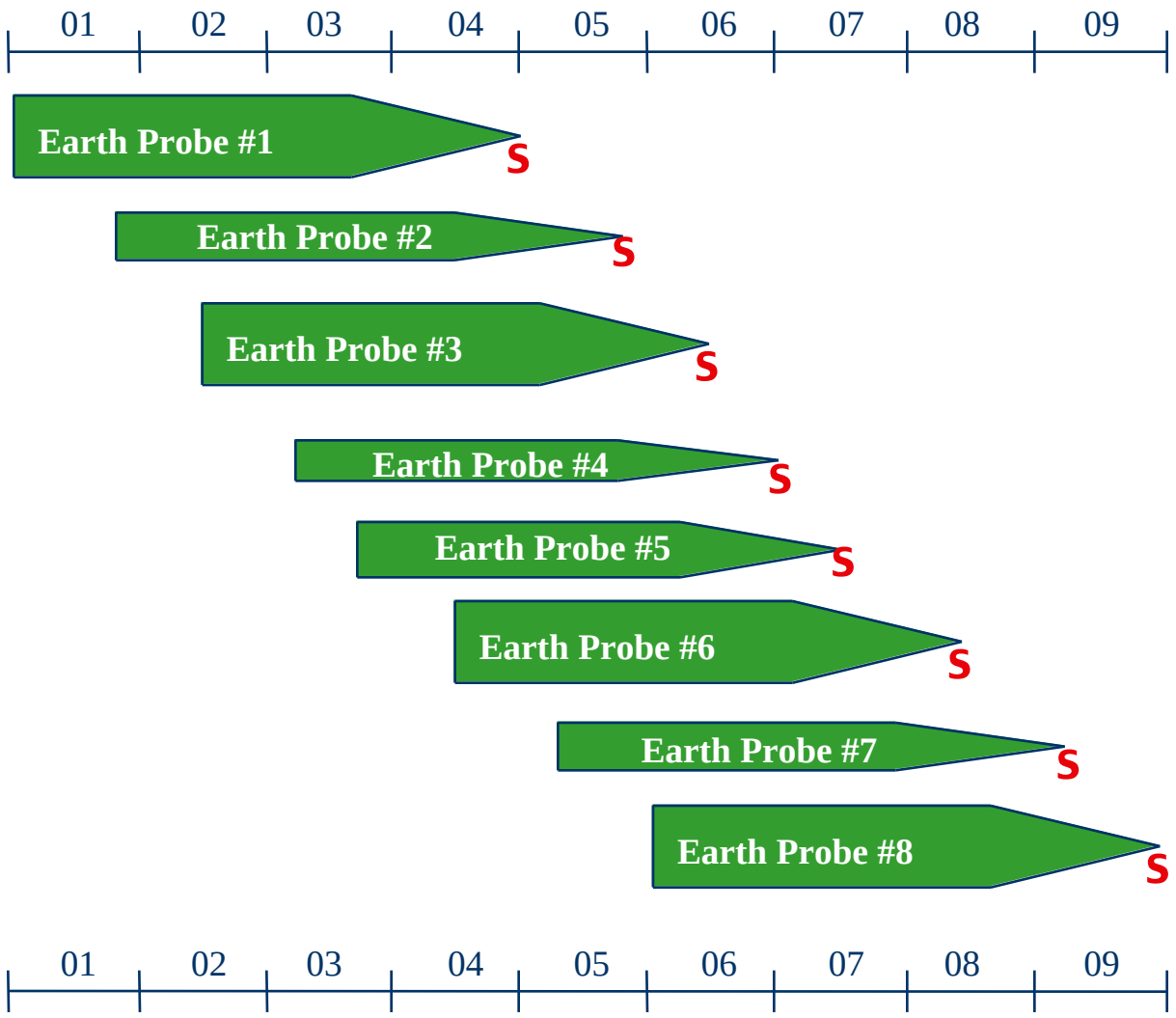
Timeline for Systematic Measurements



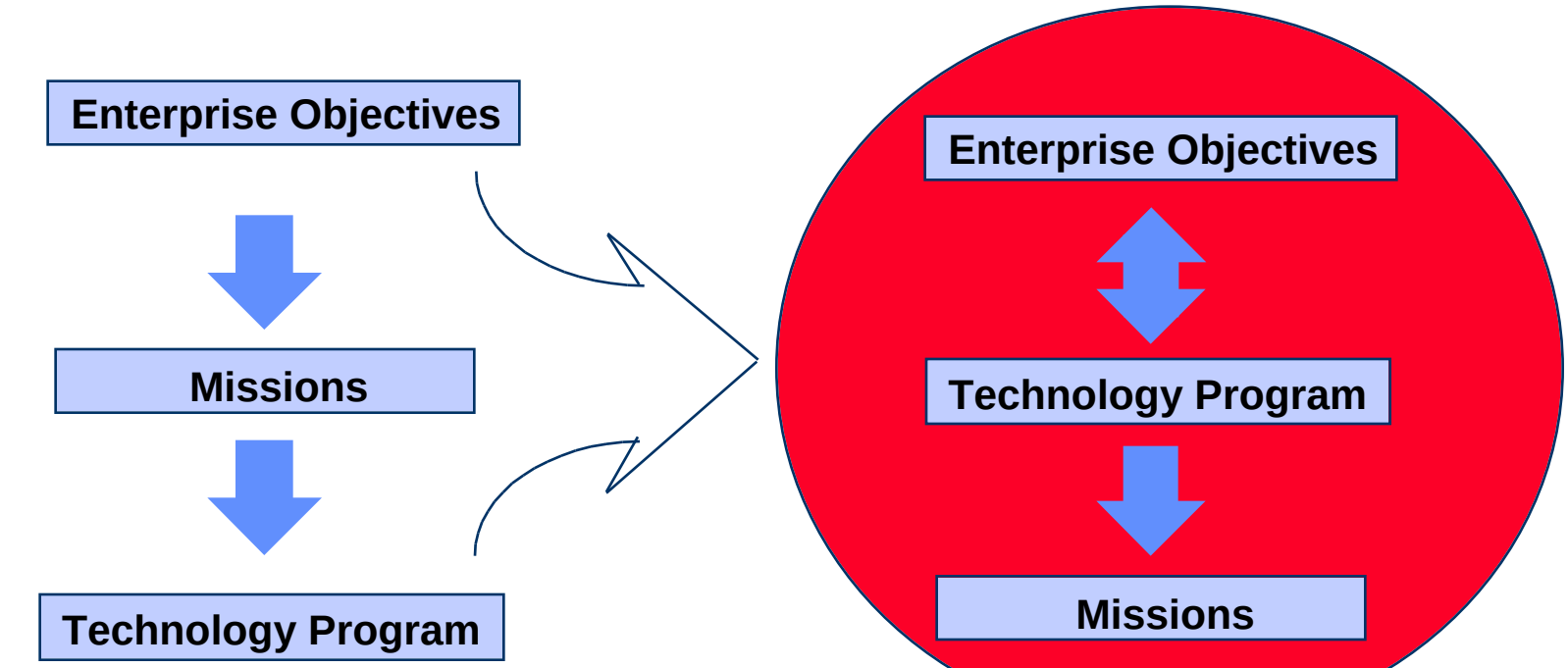
Timeline for Systematic Measurements, con't



Notional Earth Probe Mission Development Cycle



Shift from Technology Derived from Missions to Missions Enabled by Technology



Enterprise objectives established

Missions sets derived from Enterprise objectives

Technology programs derived From mission requirements

Enterprise objectives drive technology

Technology expands mission horizons

Missions evolve from convergence of objectives and technology

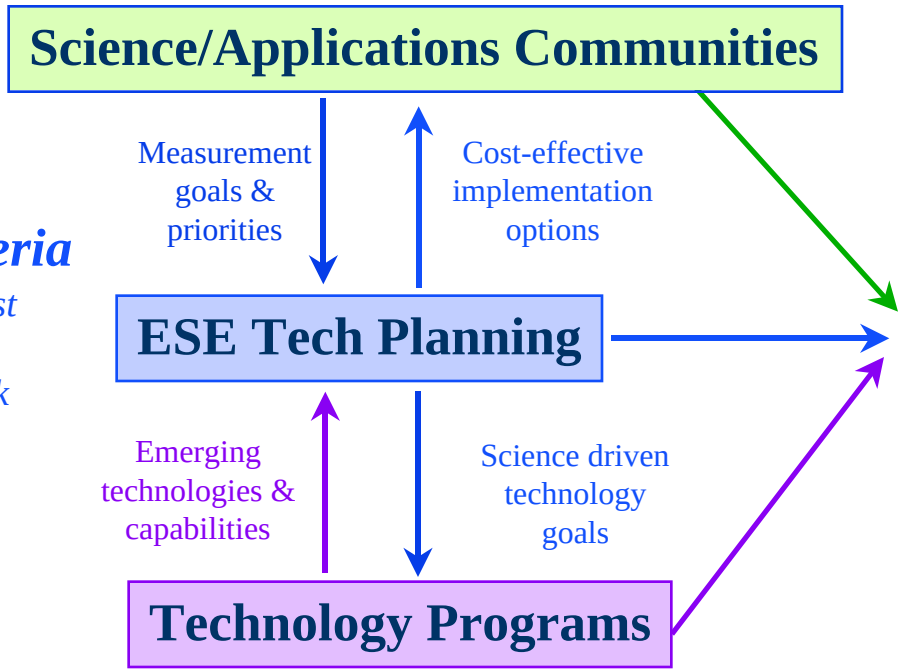
OES Technology Program Objectives

- **Reduce science product life-cycle cost**
  - » **reduce instrument weight, power, volume**
- **Enable new Earth System Science measurements**
  - » **develop and validate breakthrough systems and subsystem technologies**
- **Enable new sensor-to-science knowledge information architectures**
  - » **allow for exploitation of emerging capabilities and widely distributed operations and research activities**
  - » **seek information handling efficiency and effectiveness**

Earth Science Enterprise Strategic Technology Roadmap

	1998-2002 Establish a Presence ***Deliver world-class programs and cutting-edge technology through a revolutionized NASA***	**2003-2009** **Expand our Horizons** *Ensure continued U.S. leadership in space and aeronautics*	**2010-2023** **Develop the Frontier** *Expand human activity and space-based commerce in the frontiers of air and space*
To advance and communicate scientific knowledge and understanding of Earth, the environment of space, the solar system, and the universe	Direct the Technology Program to focus on Science driven needs (vs. mission needs) -- Instrument Incubator, Advanced Concepts, Mission Studies NMP Space validation of technologies for advanced land imaging, global wind sensing, etc.	Demonstrate a new generation of small, highly capable active, passive, and in situ instruments Develop computing and information system technologies to support powerful, coupled Earth system models	Enable a new class of frequent, low cost, and highly capable missions for broad science, educational, and applications Focus technology developments on emerging new science issues beyond sustainable development
To explore, use, and enable the development of space for human enterprise	Develop an Advanced Information Technology Testbed to explore and evaluate alternate system architectures, etc. Foster regional applications and validation technologies	Develop and implement technologies to increase the number of users of Enterprise information sets from hundreds to tens of thousands, for science, education, and applications	With commercial and operational partners, implement the international global observation/information system with broad, easy access for science, education, and applications
To research, develop, verify, and transfer advanced aeronautics, space and related technologies	Develop joint technology efforts with operational and commercial partners to facilitate transition of sustained measurements	Implement transition of key, long-term sustained measurements to operational and commercial partners	Complete transition sustained measurements and information system technologies to operational and commercial partners

Earth Science Enterprise Technology Planning Strategy



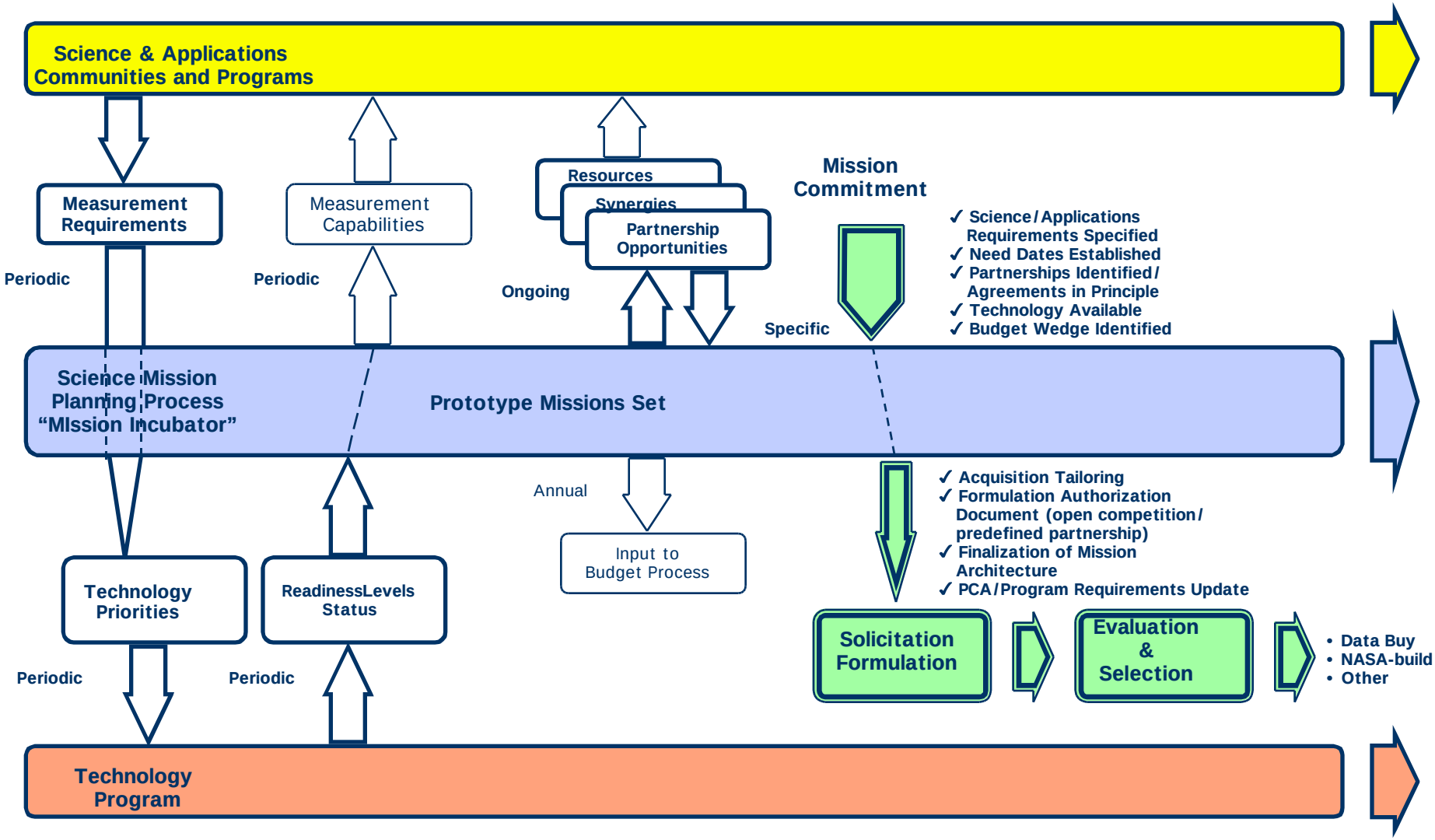
Prioritization Criteria

- *Science value/mission cost*
- *Range of applicability*
- *Technology readiness/risk*
- *Development costs*

Mission Concepts for EOS, ESSP, etc.

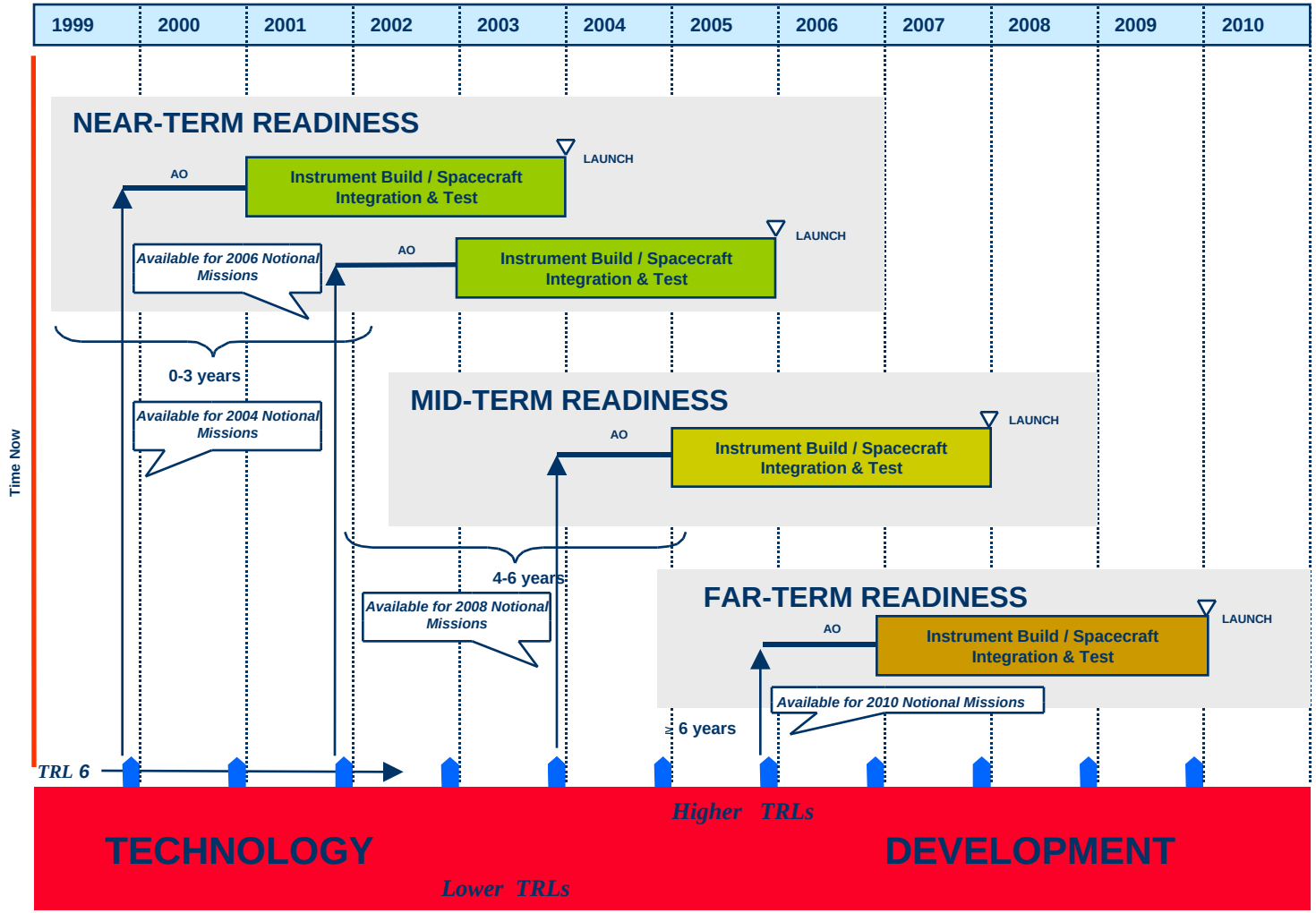
- *Address priority science*
- *Use best suitable technology*
- *Reduce development time*
- *Minimize program costs*

Science and Applications Mission Development Roadmap



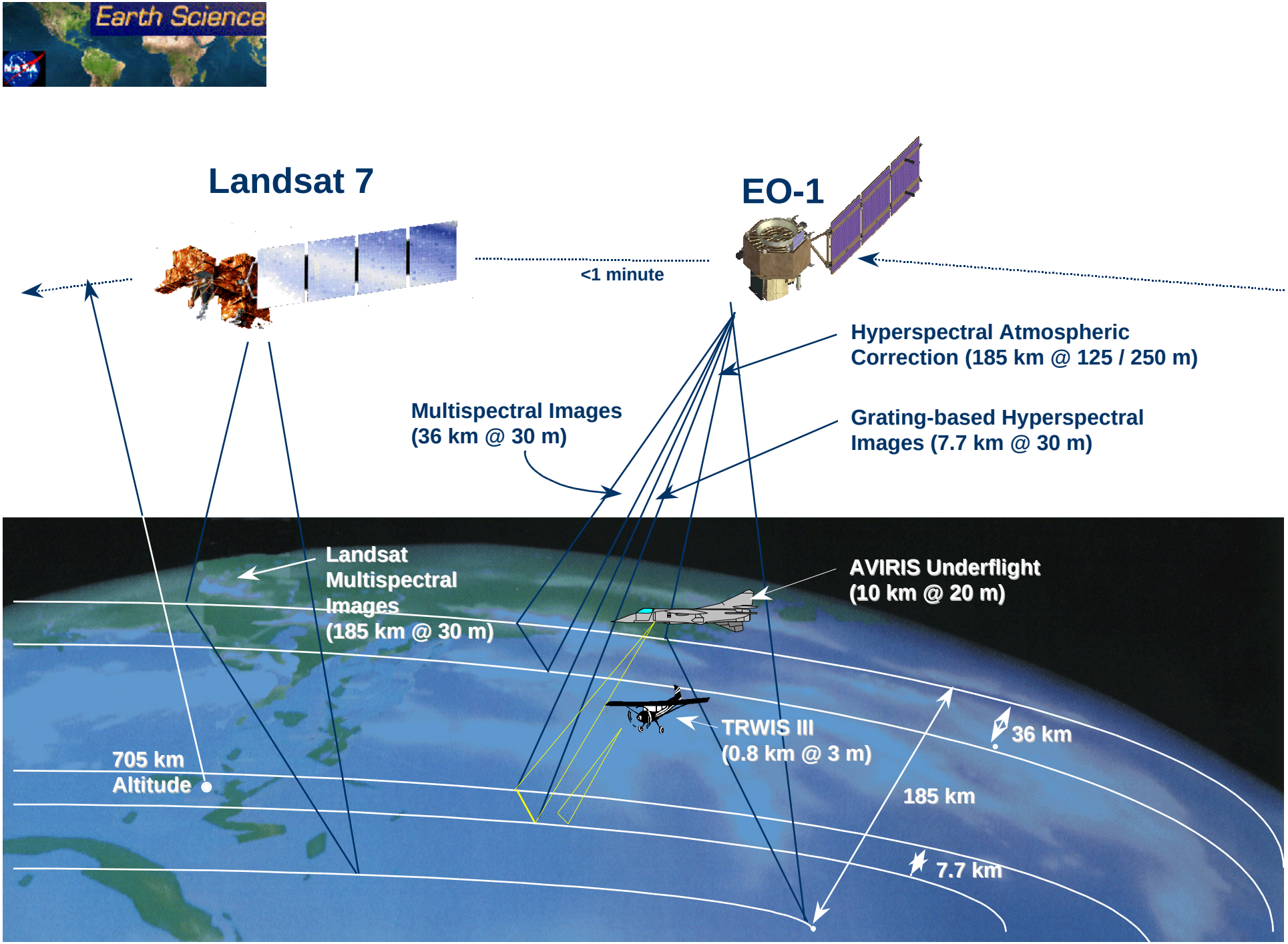
Technology Infusion into the Notional Missions

- using a biennial AO model -

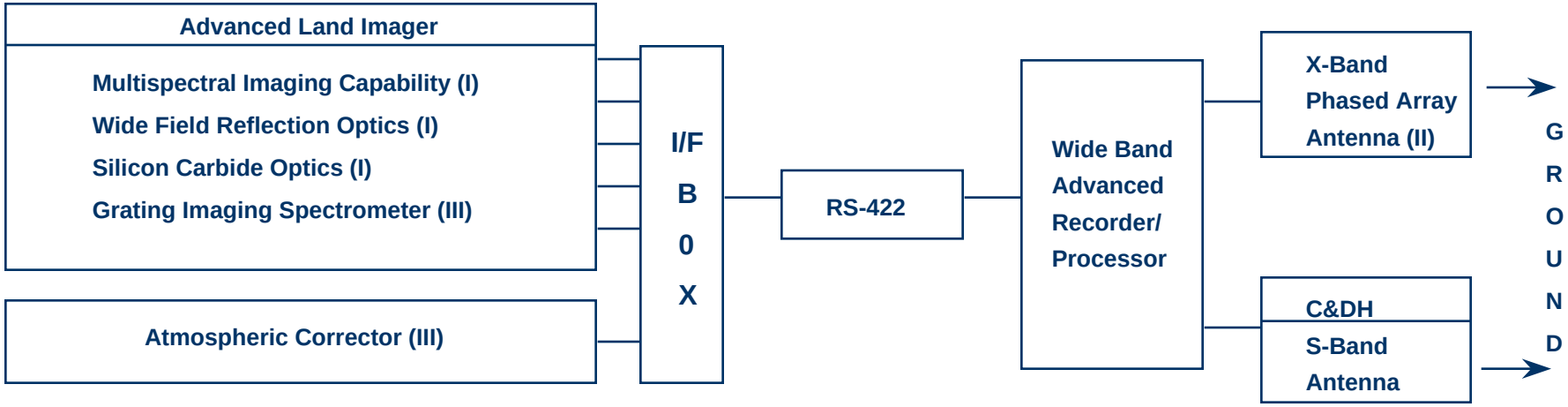


OES Near-and Mid-Term Technology Development Thrusts

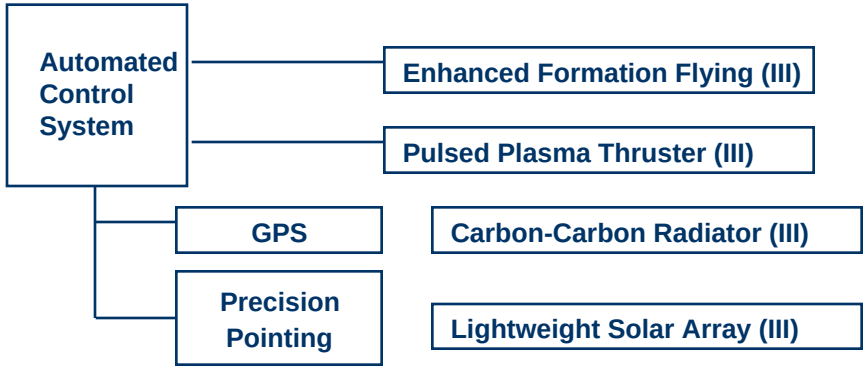
- Instrument and Measurement Technologies Development
  - Active Sensor Systems (Lidar and LightSAR)
  - Passive Miniature Atmospheric sensors and Earth surface imaging sensors
    - EO-1 Land Imager Alternatives (hyper- and multi-spectral)
    - EOS Follow-on Instrument Development
  - Airborne and In Situ Sensor Technology (R&A, co-investment with Core Technology)
- Information Systems Technologies
  - Advanced on-orbit data processing/compression techniques
    - EO-1 Fiber Optic Databus, Cloud Editing
    - EO-1 application of formation flying concepts and data synthesis
  - Advanced information systems architectures
    - EOSDIS Alternate Architecture Studies and testbeds
    - EOSDIS Federation Approach --highly distributed, advanced INTERNET interfaces
  - Supercomputing initiatives in large-scale modeling and image visualization
- Spacecraft Technologies
  - OES Reliance on Industry for Spacecraft and Spacecraft Technology (IDIQ)
  - Linkage to NASA intragency Developments
    - Core Program, SBIR, X-2000 Advanced Miniaturization
- Autonomous Operations
  - End-to-end communications, constellation architectures, intelligent systems


Earth Science
Landsat 7
EO-1
<1 minute
Hyperspectral Atmospheric
Correction (185 km @ 125 / 250 m)
Multispectral Images
(36 km @ 30 m)
Grating-based Hyperspectral
Images (7.7 km @ 30 m)
Landsat
Multispectral
Images
(185 km @ 30 m)
AVIRIS Underflight
(10 km @ 20 m)
TRWIS III
(0.8 km @ 3 m)
705 km
Altitude
36 km
185 km
7.7 km

EO-1 Technologies

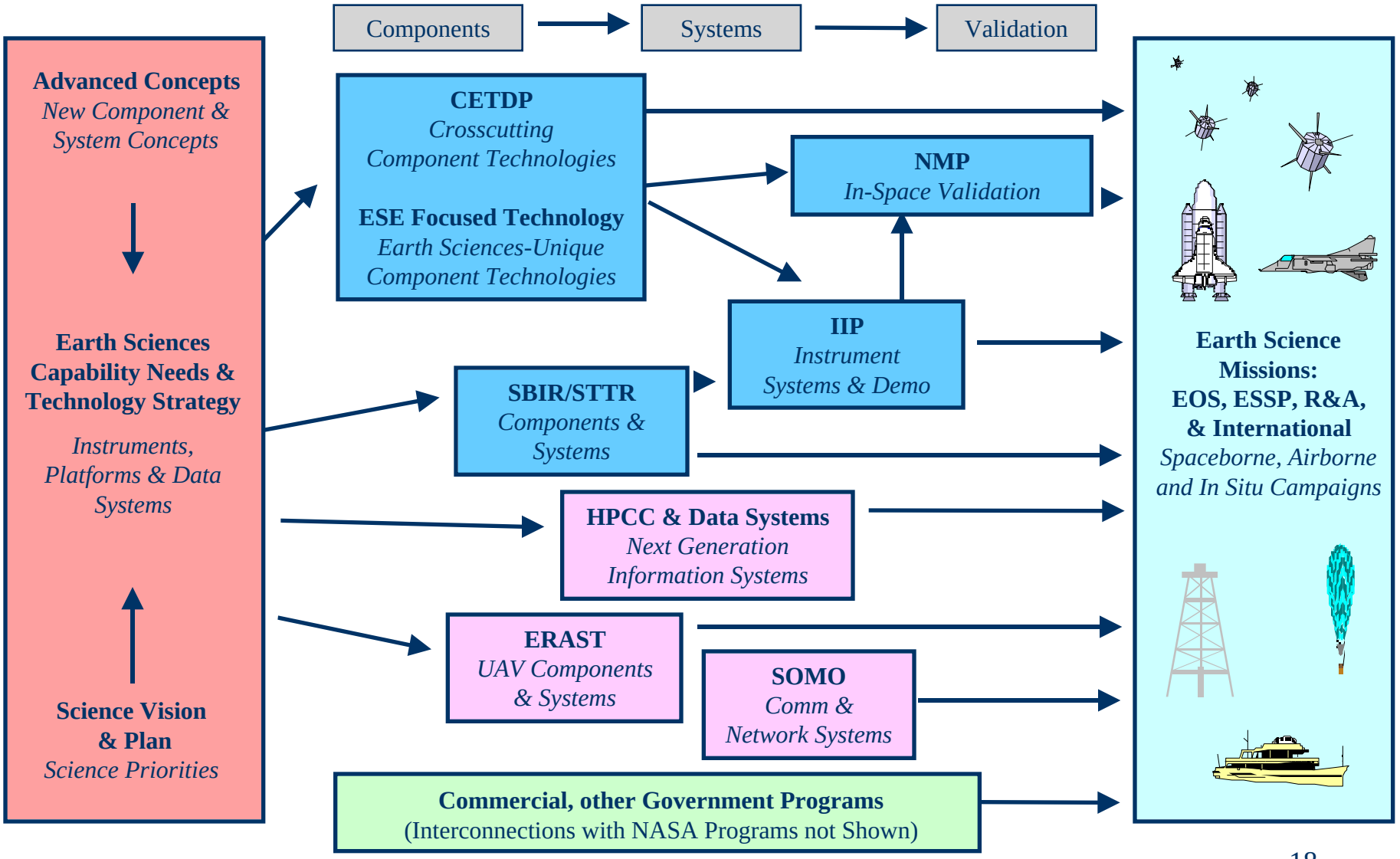


Technology	Developer
Multispectral Imaging Capability (I) Wide Field, High Resolution, Reflective Optics (I) Silicon Carbide Optics (I)	Lincoln Lincoln Lincoln
X-Band Phased Array Antenna (II)	Boeing
WARP GPS Precision Pointing Subtotal	GSFC Loral Litton
Grating Imaging Spectrometer (III) Atmospheric Corrector (III) Enhanced Formation Flying (III) Carbon-Carbon Radiator (III) Lightweight Solar Array (III) Pulsed Plasma Thruster (III)	TRW GSFC GSFC CSRP L-M Primex

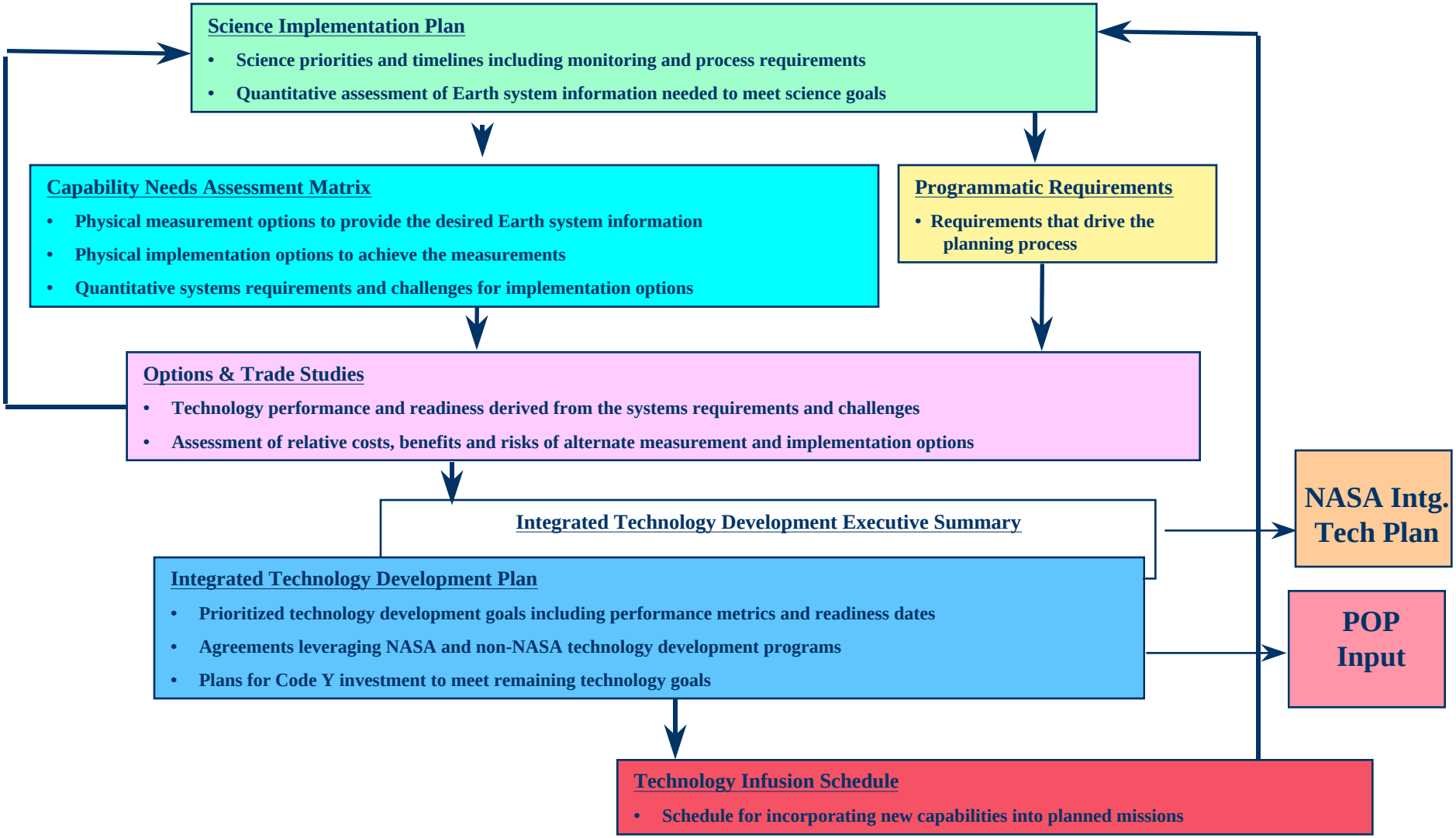


*Precision Pointing driven by WIS Validation Requirements

Technology Development Program Elements



Near Term Technology Planning Activities



Next Steps

- **Review of actions from ESE Senior Management Council 4 December**
- **Initial thoughts on related Technology Program implementation**
- **Organization of a follow-on Working Group**
- **Assignment of actions and personnel**

Actions From ESE Senior Management Council

- **(To be provided)**